

Inventory & Monitoring Division

National Park Service



Standard Operating Procedure 3.11.11

Quality Assurance and Quality Control for Landscape Dynamics Metrics: Total and Percent Area for Impervious Surface

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Summary

This internal Landscape Dynamics SOP provides guidance on QA/QC process for land cover impervious surface metric statistics.

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Overview

This SOP provides instruction on how to QA\QC in SQL Server final summary statistics for land cover impervious surface metrics (SOP 3.11.5; Kinseth and Nelson 2018a).

Statistics can represent various areas of analysis (AOA). At a minimum, AOAs include all HUC12 watersheds that intersect boundaries of IMD parks (SOP 2.11.7; Kinseth and Nelson 2018b). Custom AOAs can be submitted by Networks or Cooperators for analysis for areas of interest to a Network (SOP 2.11.8; Kinseth and Nelson 2018b).

Impervious surface statistics are derived from the most recent Nation Land Cover Dataset (NLCD) Impervious surface data, released by Multi-Resolution Land Characteristics Consortium (MRLC) (SOP 2.11.11; Kinseth and Nelson 2018c). Impervious Surface statistics are limited to those AOAs that are within the extent of the source data (NLCD; U.S. Geological Survey Multi-resolution Land Characteristics Consortium 2014).

Statistics for impervious surface include total area of each impervious land cover class (in km²), the percent total area of each impervious land cover class within the AOA, impervious patch size based on class, frequency of impervious patch size, minimum/maximum/average impervious patch size, and the total number of impervious patches.

It is assumed users of this SOP have prior knowledge of data paths, file locations, and repositories referenced in this SOP.

Requirements

- Knowledge and ability to use SSMS (SQL Server Management Studio)
- Read/write database security privileges for StatsQA and LD_Stage
- Run land cover impervious surface area and percent area statistics (SOP 3.11.5; Kinseth and Nelson 2018a).

QA Processing & Procedures

Steps 1 to 3 can be accomplished by any IMD-GIS staff. Steps 4 and 5 can only be accomplished by select IMD-GIS staff with elevated permissions within the database.

- Connect to SSMS and view the tables within the StatsQA database in SSMS. There may be multiple impervious surface stats tables for various years, extents, and AOA types.
- Repeat steps 1, 2 for each impervious surface statistics (LPI) table in StatsQA.

Naming convention for statistics tables:

LPI_<AOA>_NLCD<YYYY>_<STATS>

Where:

YYYY = Year of source data

AOA = AOA type (i.e. HUC12, or defined type from Custom AOA feature class)

STAT = GROUPED_PATCHSIZE_STATS, GROUPED_STATS

Step 1: Quality Assurance

ALL TABLES

1. View table and look for any NULL fields in DATE_CALC. If there are any, stop. Statistics may have to be rerun. If there are no NULLs, continue with QA.
2. Check all AOAs of interest are represented in the table. The number of rows should match the number of features from the input AOA feature class list (if there is a discrepancy, stop immediately):

```
SELECT Count(  
    [CLASSNAME])  
    , [AOA_NAME]  
  
FROM [StatsQA].[dbo].[STATS TABLE NAME GOES HERE]  
  
group by [AOA_NAME]  
  
order by [AOA_NAME]
```

“GROUPED_PATCHSIZE_STATS” TABLE ONLY

1. Calculate the cell count and compare to the reported count. Count_ and COUNT_CHECK should be equal (accounting for rounding):

```
SELECT TOP .25 PERCENT [AOA_NAME], [FREQUENCY], [G_VALUE], [CLASSNAME],  
[Patch_SQKM], [Count_], ((([Patch_SQKM]*1000000)/900)*[FREQUENCY]) AS  
[COUNT_CHECK]  
  
FROM [StatsQA].[dbo].[STATS TABLE HERE]  
  
ORDER BY NEWID();
```

2. Right click on table → Design. Edit field “Count_” to “Count” and save.
3. Populate Codes for MIN, MAX, Avg, TOT, and Frequency:
 - a. In SSMS, open NLCD_LPI_Freq_CodeJoins.sql; all .sql scripts can be found in the repository.
 - b. Edit the sql script as needed, changing target stats tables or other parameters where appropriate.

sql Code Example:

```
Update a set a.[Code_MIN_PatchSize] = b.Code
from [LD_Stage].[config].[LandscapeDynamicsMetrics] as b
INNER JOIN
[StatsQA].[dbo].[LPI_CONUS_HUC12_NLCD2001V11_GROUPED_PATCHSIZE_STATS] as a
on a.CLASSNAME = b.Classname
where b.MeasureType = 'Impervious Surface' and b.ParameterType = 'Minimum
Patch Size';
```

“GROUPED_STATS” TABLE ONLY

1. Right click → Select Top 1000 rows → Delete “TOP 1000” from query
 - a. Sort by area; look for any ZERO or NEGATIVE values. If AREA_SQKM, or TAREA_SQKM, is ZERO, Count_ should also be ZERO. Add the following to the end of the select statement, one at a time (hint: two dash marks before a line of SQL will comment it out):

```
order by [TAREA_SQKM]
```

```
order by [AREA_SQKM]
```

2. Run a query to compare the raster calculated area of the AOA to the AOA source vector area ((AREA_SQKM) – (TOTAL_AOA_AREA_SQKM) = DIFF). All DIFF values should range between 0.1 and -0.1, and any negative values outside this range should be representative of coastal and/or border AOAs (visually check AOAs in ArcGIS, if unsure):

```
SELECT SUM([AREA_SQKM]) as [SUM_T], [AOA_NAME],
[TOTAL_AOA_AREA_SQKM], (SUM([AREA_SQKM]) - [TOTAL_AOA_AREA_SQKM])
AS [DIFF]
FROM [StatsQA].[dbo].[STATS TABLE NAME GOES HERE]
GROUP BY [AOA_NAME], [TOTAL_AOA_AREA_SQKM]
order by [DIFF] desc
```

3. Verify PCT_AREA values in the results table. The values for fields [PCT_AREA] and [PCT_AREA_CHECK] should be equivalent up to three decimal places:

```
SELECT TOP .25 PERCENT [AOA_NAME], [CLASSNAME], [AREA_SQKM],
[TAREA_SQKM], [PCT_AREA], ([AREA_SQKM]/[TAREA_SQKM])*100
AS [PCT_AREA_CHECK]
FROM [StatsQA].[dbo].[STATS TABLE NAME GOES HERE]
```

```
WHERE [TAREA_SQKM] <> 0
```

```
ORDER BY NEWID();
```

4. Calculate the SUM of PCT_AREA, by AOA. SUM_PCT should be 100%. Acceptable range is 100 +/- 0.001:

```
SELECT SUM([PCT_AREA]) AS [SUM_PCT], [AOA_NAME]
```

```
FROM [StatsQA].[dbo].[STATS TABLE NAME GOES HERE]
```

```
group by [AOA_NAME]
```

```
order by [SUM_PCT]
```

Step 2: Manage Data

Run the query below to fill in any absent impervious surface classes, by AOA, for “grouped_stats” table only. This assumes all AOAs have at least one impervious class present – which should always be true.

“GROUPED_STATS” TABLE ONLY:

```
INSERT INTO [StatsQA].[dbo].[STATS TABLE HERE] ([Value], [Count_],  
[CLASSNAME], [TOTAL_AOA_AREA_SQKM],
```

```
[TAREA_SQKM], [AREA_SQKM], [PCT_AREA], [AOA_NAME], [DATE_CALC],  
[PARK_CODE], [CreateDate], [DATA_YEAR], [DATA_VERSION], [AOA_DATE],  
[Code_Class_Area], [Code_Percent_Class])
```

```
SELECT DISTINCT X.[OUT_VAL], 0.0, X.[CLASSNAME],  
X.[TOTAL_AOA_AREA_SQKM],
```

```
X.[TAREA_SQKM], 0.0, 0.0, X.[AOA_NAME], X.[DATE_CALC], X.[PARK_CODE],  
X.[CreateDate], X.[DATA_YEAR], X.[DATA_VERSION], X.[AOA_DATE],  
X.[Code_Class_Area], X.[Code_Percent_Class]
```

```
FROM [LD_Stage].[dbo].[tlu_NLCD_LPI_GROUPED]
```

```
LEFT OUTER JOIN (SELECT  
[LD_Stage].[dbo].[tlu_NLCD_LPI_GROUPED].[OUT_VAL],
```

```
[LD_Stage].[dbo].[tlu_NLCD_LPI_GROUPED].[CLASSNAME],
```

```
[StatsQA].[dbo].[STATS TABLE HERE].[TOTAL_AOA_AREA_SQKM],
```

```
[StatsQA].[dbo].[STATS TABLE HERE].[TAREA_SQKM],
```

```
[StatsQA].[dbo].[STATS TABLE HERE].[AOA_NAME],
```

```
[StatsQA].[dbo].[STATS TABLE HERE].[DATE_CALC],
```

```
[StatsQA].[dbo].[STATS TABLE HERE].[PARK_CODE],
```

```

[StatsQA].[dbo].[STATS TABLE HERE].[CreateDate],
[StatsQA].[dbo].[STATS TABLE HERE].[DATA_YEAR],
[StatsQA].[dbo].[STATS TABLE HERE].[DATA_VERSION],
[StatsQA].[dbo].[STATS TABLE HERE].[AOA_DATE],
[StatsQA].[dbo].[STATS TABLE HERE].[Code_Class_Area],
[StatsQA].[dbo].[STATS TABLE HERE].[Code_Percent_Class]
FROM [LD_Stage].[dbo].[tlu_NLCD_LPI_GROUPED]
CROSS JOIN
[StatsQA].[dbo].[STATS TABLE HERE])
AS X ON X.[CLASSNAME]=
[LD_Stage].[dbo].[tlu_NLCD_LPI_GROUPED].[CLASSNAME]
WHERE X.[CLASSNAME] NOT IN
(SELECT [StatsQA].[dbo].[STATS TABLE HERE].[CLASSNAME]
FROM [StatsQA].[dbo].[STATS TABLE HERE]
WHERE [StatsQA].[dbo].[STATS TABLE HERE].[AOA_NAME] = X.[AOA_NAME]);

```

1. Any absent land cover classes should have been inserted. Check row count again:

```

SELECT Count(
    [CLASSNAME])
    , [AOA_NAME]
FROM [StatsQA].[dbo].[STATS TABLE NAME GOES HERE]
group by [AOA_NAME]
order by [AOA_NAME]

```

- a. Check the following:
 - a. All rows should have the same count
 - b. The number of rows should match number of AOAs in the input feature class as above (Step 1.2)
2. Right click on table → Design. Edit field “Count_” to “Count” and save.
3. Populate fields ‘Code_Class_Area’ and ‘Code_Percent_Area’.

- a. In SSMS, open NLCD_LPI_CodeJoins.sql; all .sql scripts can be found in the repository.
- b. Edit the sql script as needed, changing target stats tables or other parameters where appropriate.

sql Code Example:

```
Update a set a.[Code_Class_Area] = b.Code
from [LD_Stage].[config].[LandscapeDynamicsMetrics] as b
INNER JOIN [StatsQA].[dbo].[LPI_CONUS_HUC12_NLCD2001V11_GROUPED_STATS] as a
on a.CLASSNAME = b.Classname
where b.MeasureType = 'Impervious Surface' and b.ParameterType = 'Class
Area';
```

```
Update a set a.[Code_Percent_Area] = b.Code
from [LD_Stage].[config].[LandscapeDynamicsMetrics] as b
INNER JOIN [StatsQA].[dbo].[LPI_CONUS_HUC12_NLCD2001V11_GROUPED_STATS] as a
on a.CLASSNAME = b.Classname
where b.MeasureType = 'Impervious Surface' and b.ParameterType = 'Percent
Area';
```

Step 3: Combine Statistics

Where applicable, combine data with matching: source/year/metric/AOA to create one table of impervious surface statistics.

Go to Step 4 if there are no tables to combine.

“GROUPED_PATCHSIZE_STATS” TABLE ONLY

1. Create a new ‘grouped_patchsize_stats’ table for combined LPI (by source, year, AOA). Add the following to the select statement, on the line above “From”:

```
INTO [StatsQA].[dbo].[NEW TABLE HERE]
```

Naming convention for **new** tables should match existing table names in LD_Stage, for the same metric (if any).

Example New Table =

```
[StatsQA].[dbo].[NLCD2011v11_lpi_grouped_patchsize_stats_HUC12]
```

2. Refresh StatsQA and look for the new table.
3. Insert additional impervious surface statistics to the new destination table, repeat for each table to be added:

```
INSERT INTO [StatsQA].[dbo].[NEW TABLE HERE]
( [FREQUENCY]
, [PATCH_SQKM]
```

```

, [G_VALUE]
, etc. with all remaining fields)

SELECT [FREQUENCY]

, [PATCH_SQKM]

, [G_VALUE]

, etc. with all remaining fields

FROM [StatsQA].[dbo].[SOURCE TABLE]

```

4. When done, check combined table:

```

SELECT Count(

    [CLASSNAME] )

, [AOA_NAME]

FROM [StatsQA].[dbo].[NEW/DESTINATION TABLE HERE]

group by [AOA_NAME]

```

Classname count per row should be the same for all rows. Confirm all AOAs are present; the number of rows should equal the sum of all AOAs from the individual tables that were merged.

“GROUPED_STATS” TABLE ONLY

1. Create a new ‘grouped_stats’ table for combined LPI (by source, year, AOA). Add the following to the select statement, and the line above “From”:

```

INTO [StatsQA].[dbo].[NEW TABLE HERE]

```

Naming convention for **new** tables should match table names in LD_Stage, for the same metric (if any):

Example New Table = [StatsQA].[dbo].[NLCD2011v11_lpi_grouped_stats_HUC12]

2. Refresh StatsQA and look for the new table.
3. Insert additional impervious surface statistics to the new destination table, repeat for each table to be added:

```

INSERT INTO [StatsQA].[dbo].[NEW/DESTINATION TABLE]

([Value]

, [Count]

, [CLASSNAME]

```

```

, etc. with all remaining fields)
SELECT [Value]
      , [Count]
      , [CLASSNAME]
      , etc. with all remaining fields
FROM [StatsQA].[dbo].[SOURCE TABLE]

```

4. When done, check merged table(s):

```

SELECT Count(
      [CLASSNAME])
      , [AOA_NAME]
FROM [StatsQA].[dbo].[NEW/DESTINATION TABLE HERE]
group by [AOA_NAME]

```

Classname count per row should be the same for all rows. Confirm all AOAs are present; the number of rows should equal the total of all AOAs from the individual tables that were merged.

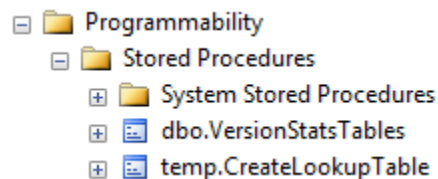
Step 4: Replace Statistics Data – All AOAs

Skip to Step 5 if updating/adding a partial list of AOA statistics

Move the final tables from StatsQA to the LD_Stage database when all QA checks are complete and all data values are as they should be (requires elevated privileges). If adding new YYYY data/statistics, go to #2.

1. Version previous LPI LD_Stage tables (if applicable)

- a. In LD_Stage, expand Programmability → Stored Procedures:



- b. Right click on dbo.VersionStatsTables → “Script Stored Procedure As” → EXECUTE TO → New Query Window.
 - c. Replace @fromTable with the name of the table to be versioned, in single quotes (example below in red):

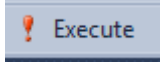
```

DECLARE @RC int
DECLARE @fromTable varchar(60)

-- TODO: Set parameter values here.

EXECUTE @RC = [dbo].[VersionStatsTables]
        'LandCoverImperviousSurface_Grouped_NLCD'
GO

```

d. Click  to date-stamp existing table.

e. Refresh to see table with date stamp appended:

  **dbo.nlcd2011_lpi_grouped_patchsize_stats_Custom_2016-12-27**

2. “**GROUPED_PATCHSIZE_STATS**”, copy the new statistics table into LD_Stage.

a. Right click on table → Script Table As → Select To → New Query Editor Window

```

SELECT [OBJECTID]
      , [FREQUENCY]
      , [Patch_SQKM]
      , [G_VALUE]
      , CONVERT(int, [Count]) Count
      , etc. for all remaining fields

INTO [LD_Stage].[dbo].[STATS TABLE NAME GOES HERE]

FROM [StatsQA].[dbo].[STATS TABLE NAME GOES HERE]

```

Name the NEW LD_Stage table as follows:

**[SourceYYYYv11_metric_grouped_patchsize_stats_AOA] →
[nlcdYYYYv11_lpi_grouped_patchsize_stats_HUC12]**

b. EXECUTE the Query

c. REFRESH LD_Stage and look for the table. It should be adjacent to the date-stamped table (if any).

3. “**GROUPED_STATS**”, copy the new statistics table into LD_Stage.

a. Right click on table → Script Table As → Select To → New Query Editor Window

```

SELECT [OBJECTID]

```

```
, [Value]

, CONVERT(int, [Count]) Count

, [CLASSNAME]

, etc for all remaining fields
```

```
INTO [LD_Stage].[dbo].[STATS TABLE NAME GOES HERE]
FROM [StatsQA].[dbo].[STATS TABLE NAME GOES HERE]
```

Name the NEW LD_Stage table as follows:

```
[SourceYYYYv11_metric_grouped_stats_AOA] →
[nlcdYYYYv11_lpi_grouped_stats_HUC12]
```

- b. EXECUTE the Query
 - c. REFRESH LD_Stage and look for the table. It should be adjacent to the date-stamped table (if any).
4. In LD_Stage, change schema of date-stamped table(s) from dbo to zArchive:

```
ALTER SCHEMA zArchive TRANSFER dbo.[DATE STAMP TABLE NAME HERE] ;
```

5. Refresh LD_Stage and check all date-stamp tables are moved from dbo to zArchive.

Tables example, zArchive:



```
zArchive.nlcd2011_lpi_grouped_patchsize_stats_Custom_2016-12-27
zArchive.nlcd2011_lpi_grouped_patchsize_stats_Custom_2017-06-28
zArchive.nlcd2011_lpi_grouped_patchsize_stats_HUC12_2017-07-18
zArchive.nlcd2011_lpi_grouped_stats_Custom_2016-12-27
zArchive.nlcd2011_lpi_grouped_stats_Custom_2017-06-28
zArchive.nlcd2011_lpi_grouped_stats_HUC12_2017-07-18
```

6. Delete the moved tables from StatsQA.

7. **Go to Step 6 – Manage Data Views**

Step 5: Replace Statistics Data – Select AOAs

Move stats table of interest from LD_Stage to StatsQA and replace data for AOAs that have been updated, or add data for new AOAs to the table.

1. Append updated statistics or add new AOA statistics to existing statistics tables:
 - a. Copy the table to be updated FROM LD_Stage to StatsQA:
Right click LD_Stage table → Script Table As → Select To → New Query Window

```
INTO [StatsQA].[dbo].[STATS TABLE NAME_copy]
```

```
FROM [LD_Stage].[dbo].[STATS TABLE NAME]
```

- b. Get initial count of AOAs:

```
SELECT Count(  
    [CLASSNAME])  
    , [AOA_NAME]  
FROM [StatsQA].[dbo].[STATS TABLE NAME_copy]  
group by [AOA_NAME]
```

8. Delete from the “_copy” table all AOAs/rows to be replaced

- a. Right click → Edit Top 200 Rows → click white sql button and edit query as needed

- i. Select and delete AOAs/rows that are updated.
Edits are immediate and cannot be undone – make sure you are editing the appropriate table.

- b. Or, edit sql statement as needed. Run.

```
DELETE FROM [StatsQA].[dbo].[STATS TABLE NAME_copy]  
where AOA_NAME like 'APIS%'  
OR AOA_NAME like 'AZRU%'  
OR AOA_NAME like 'BIBE%'  
OR AOA_NAME like 'BITH%'  
OR AOA_NAME like 'BLCA%'  
OR AOA_NAME like 'CARL%'  
,...add/edit as needed
```

- i. Deleted rows cannot be undone. Make sure to delete from the appropriate table.

9. Query for new count on edited table:

```
SELECT Count(  
    [CLASSNAME])  
    , [AOA_NAME]  
FROM [StatsQA].[dbo].[STATS TABLE NAME_copy]
```

```
group by [AOA_NAME]
```

10. Insert new/updated statistics from the newly created base table into the ‘_copy’ of the table (make sure to match fields based on table being updated; exclude field ‘OBJECTID’):

```
INSERT INTO [StatsQA].[dbo].[STATS TABLE NAME_copy]
```

```
([FIELD LIST HERE]
```

```
. . .)
```

```
SELECT [FIELD LIST HERE]
```

```
FROM [StatsQA].[dbo].[NEW BASE TABLE HERE]
```

11. Check Count. The number of rows should have increased by the number of AOAs added in the previous step and should now reflect required total for AOA type.

```
SELECT Count(
```

```
[CLASSNAME])
```

```
, [AOA_NAME]
```

```
FROM [StatsQA].[dbo].[STATS TABLE NAME_copy]
```

```
group by [AOA_NAME]
```

12. Visually check “_copy” table for applied updates.

- a. Right click → “Select Top 1000 rows”

- i. Order by AOA_Name

- ii. Order by OBJECTID

- iii. Other queries

13. **Go to STEP 4 – Replace Statistics Data – All AOAs** and follow steps to replace/update tables in LD_Stage

Step 6: Manage Data Views

If required, go to Inventory and monitoring database documentation: Environmental Setting Protocol SOP (SOP 7.1.1; Kinseth et al. 2018) and check the Landscape Dynamics portion.

Literature Cited

- Kineth, M. and L. Nelson. 2018a. Calculating statistics for national landscape dynamics metrics: Impervious surface. Inventory & Monitoring Program Standard Operating Procedure NPS/NRSS/IMD/SOP—3.11.5. National Park Service, Fort Collins, Colorado.
- Kineth, M. and L. Nelson. 2018b. Creating custom areas of analysis for use as a part of the IMD Environmental Settings Protocol. Inventory & Monitoring Program Standard Operating Procedure NPS/NRSS/IMD/SOP—2.11.8. National Park Service, Fort Collins, Colorado.
- Kineth, M. and L. Nelson. 2018c. Processing land cover source data to derive landscape dynamics metrics: Impervious surface. Inventory & Monitoring Program Standard Operating Procedure NPS/NRSS/IMD/SOP—2.11.11. National Park Service, Fort Collins, Colorado.
- Kineth, M., L. Nelson, and S. Schupbach. 2018. Inventory and monitoring database documentation: Environmental Setting Protocol. Inventory & Monitoring Division Standard Operating Procedure NPS/NRSS/IMD/SOP—7.1.1. National Park Service, Fort Collins, Colorado.
- U.S. Geological Survey Multi-resolution Land Characteristics Consortium. 2014. NLCD 2011 Percent Developed Imperviousness (2011 Edition) website. <https://www.mrlc.gov/index.php> (accessed 5/19/2014).

Appendix 1: Data Availability and Known issues

Data availability

Impervious Surface data is provided by NLCD and is currently only available for certain extents. Not all geographies/AOAs will have data available to calculate Impervious Surface summary statistics.

Data Issues

PARK_CODE is valid for AOAs derived specifically from individual parks. Some Custom AOAs are not park-based and therefore will not have a PARK_CODE value.